FULL LENGTH RESEARCH ARTICLE

INTERACTION OF CRUDE OIL AND MANURE TREATMENTS AND ITS EFFECTS ON THE AGRONOMIC CHARACTERISTICS OF MAIZE (*Zea mays* L.)

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ABSTRACT

An experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State, University, Owerri Nigeria to investigate the interaction of crude oil and manure on the agronomic characteristics of maize. The experiment was arranged in Randomized Complete Block Design of a split plot fashion with four main plots represented by the levels of crude oil pollution (0 ml, 100 ml, 200 ml, & 300 ml), while the organic manure (poultry manure, cow dung manure and farm yard manure) and a control (no treatment) plots made up the subplots. The set up was replicated four times. Soil collected from the University's farm site was used to fill 64 buckets of 30 cm^3 capacity each to 2/3 of their volumes. Crude oil was applied to the buckets according to the levels. Organic manure was applied 14 days after pollution at the rate of 2Kg/20Kg of soil, while the maize seeds (Obatampa variety) were planted at 28 days after pollution. Soil samples were collected for physical and chemical analysis before application of crude oil and 28 days after application of crude oil. The germination percentage was determined two weeks after planting. Plant height (cm) and leaf length (cm) were determined at 3 and 6 wks after planting, while cob length (cm), cob diameter (cm), number of seeds per cob and weight (g) of 100 seeds were determined at maturity. Results showed that application of manure significantly influenced the growth and performance of maize plant in the crude oil polluted soil. Poultry manure significantly improved the agronomic characteristics of maize more than the cow dung and farm yard manure in the crude oil polluted soil. This indicated that poultry manure exhibited a higher remedial potential of the crude oil-polluted soil than the other organic manures (cow dung and farm yard manure). The results further showed that application of poultry manure positively interacted with crude oil and it is therefore recommended to be used in the remediation of crude oil degraded soils.

***Key words*:**Crude oil, Zea mays,Interaction, Organic manure, Remediation

INTRODUCTION

Among cereals, maize is an important food and feed crop which ranks third after wheat and rice in the world (Rasheed *et al*. 2004). It is recognized as a leading commercial crop of great agro-economic value owing to its expanded use in the agro-industries (Rasheed *et al*. 2004), in addition to being a staple food crop for the common man in Nigeria. Among the factors responsible for the decrease in the productivity of the crop in Nigeria, crude oil pollution of arable soil is considered to be the major one (Onweremadu & Duruigbo 2007). The effects of crude oil on the growth and germination of maize has been reported (Ogboghodo *et al.* 2001). The phytotoxic effects of crude oil on other crops such as red beans, okra and *Telferia* seedlings have also been documented (Asuquo *et al.* 2001; Baek & Kim, 2004).

Many researchers have reported the effect of crude oil on the soil and the capacity of some organic manure in the remediation of oil polluted soils (Kayode & Agboola 2003). Although several methods have been used to remediate soils contaminated with inorganic chemicals, the recent is the use of micro-organisms (James *et al*. 1996) through a process called Bioremediation (Sasikumar & Taniya 2003). It is a biotechnological approach of rehabilitating areas degraded by pollutants or damages resulting from the mismanagement of the ecosystem (Adedokun & Ataga 2006). It is also the ability of microorganisms to degrade or detoxify organic contaminated area by transforming undesirable and harmful substance into non-toxic compound (Asuquo *et al.* 2001). An earlier observation by Amadi *et al*. (1994) showed that there was every indication that nutrient supplementation of oil-polluted soils with organic nutrient sources is beneficial for the growth of maize. The present article therefore studied the interaction of crude oil and organic manure (poultry manure, cow dung and farm yard manure) on some agronomic characteristics of the maize.

MATERIALS AND METHODS

The experiment was conducted in the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri Nigeria using a Randomized Complete Block Design arranged in a split- plot fashion, with four replications. The level of crude oil pollution (0 ml, 100 ml, 200 ml, and 300 ml) made up the main plots while organic manures (poultry manure, cow dung, farm yard manure) constituted the subplots. Maize seeds (Obatampa variety) collected from Imo State Agricultural Development Programme (IMOADP) were used as the test crop.

The organic manures were collected from the University's livestock farm, while spent engine oil collected from Nekede mechanic village in Owerri. Twenty kilogramme soil collected from the University's farm site was filled into 64, 30 cm^3 capacity buckets to 2/3 their volumes. The spent engine oil was used to pollute the soils in the buckets at various levels (0 ml, 100 ml, 200 ml and 300 ml). The polluted soils were allowed to stand under natural environment for 14 days after which the organic manures were applied by incorporating them into the soil in the buckets at the rate of 2kg of manure per 20kg of soil. At 28 days after pollution, maize seeds were sown into the soil at the rate of one seed per bucket at the dept of 3cm. Soil samples were collected from the buckets before crude oil application and 28 days after crude oil application. Weeding was done as they appear in the various buckets. Data were collected on the following: number of days before seed germination, germination percentage (%), plant height (cm), leaf length (cm), cob length (cm), cob diameter (cm) number of seeds per cob and weight of 100 seeds (g). Analysis of variance (ANOVA) was used to analyse the data, while mean values were separated by the Duncan Multiple Range Test (Onuh & Igwemma 2001).

RESULTS

The Table 1 showed physical and chemical properties before the application of crude oil and at 28 days after crude oil and organic manures application. There was appreciable improvement of the soil physical and chemical properties after the organic manures were applied. However, poultry manure gave the highest total nitrogen of 0.31 as against 0.03 total nitrogen recorded in the unamended plots.

Effect of manure on seed germination: The application of organic manure significantly affected the germination of maize seed. Plots treated with poultry manure, gave the highest germination percentage (98 %) and had the shortest number of days (3) to germinate, and was significantly different from the lowest germination percentage (41 %) observed from the unamended plots with the longest mean number of days (4.22) to geminate (Table 2). The plots that were not polluted with crude oil recorded 100 % germination which significantly differed from the germination percentage (45%) observed from plots polluted with 300ml of crude oil (Table 2).

Effect of Manure on Maize Growth Characteristic: Table 3 showed that the plant growth was progressive at the application of organic manure, with the highest plant height of 97.3 cm recorded 3 weeks after planting (WAP) observed from the plots amended with poultry manure. This was significantly different from the lowest plant height (51.79 cm) observed from the unamended plots. Similarly, at 6 WAP, poultry manure-treated plots gave the highest plant height (293.4 cm), while the unamended plot also gave the shortest plant height (63.9 cm) (Table 3).

At 3 WAP, the highest leaf length (36.6 cm) was observed from plots treated with poultry manure while the lowest leaf length (22.2 cm) was recorded from unamended plots. So also at 6 WAP, poultry manure-treated plots produced plants with highest leaf length (67.2 cm), which was significantly different from the 36.8 cm leaf length observed from the unamended plots (Table 3).

There was significant difference in the length of cob recorded for the different organic manure sources. Poultry manure gave the highest cob length (14.6 cm), which was significantly different from the 6.2 cm cob length observed from the unamended plots (Table 3).

Maize cob diameter was also influenced by organic manure source as the highest mean cob diameter (8.4 cm) was observed from plots amended with farmyard manure but this value was not significantly different from 8.25 cm observed from plots treated with poultry manure, however, it is significantly different from the cob diameter (2.8 cm) observed from unamended plots (Table 3).

Effect of manure on maize yield characteristics in crude oil polluted soil: The highest number of seeds per cob (265.5) was recorded from plots treated with poultry manure which was significantly different from the number of seeds per cob (87.6) recorded from the unamended plots (Table 4).

The weight of 100 seeds of maize was also influenced by manure source as plots that received poultry manure gave the highest weight (0.5 g) which was significantly different from weight of 100 seeds (0.2 g) recorded from the unamended plots. Table 4 also showed that the highest maize yield (2477.1 kg/ha) was recorded from poultry manure treated plots, which was significantly different from the 999.8kg/ha observed from the unamended plots (Table 5).

DISCUSSION

There was encouraging improvement of the soil physical and chemical properties after the application of the organic manures. Poultry manure was better in the improvement of soil nitrogen and the other properties of the soil under crude oil pollution, than the cow dung and farm yard manures.

Results obtained in this experiment revealed that germination of maize seed was affected by manure source in the crude oil-polluted soil. It was observed that poultry manure significantly amended the crude oil polluted soil when compared with the other sources of manure (Cow dung, and farm yard manure). Both Madukwe *et al.* (2008) and Christo *et al*. (2008) observed that poultry manure has greater potentials in amending crude oil-degraded soil by positively influencing the growth of cowpea more than the other sources of organic manure.

Generally, manure treated plots produced higher germination percentage than the unamended plots, which could have been due to the fact that the crude oil pollution impaired free flow of air (oxygen) into the soil, and also suppressed the activities of micro-organisms that would have helped in the degradation of harmful substances inhibiting seed germination (Basra *et al.* 2006).

Even though application of manure generally influenced the growth characteristics of maize plants, poultry manure showed exceptional potentials in its influence on the maize plant growth and this was progressive as the maize plant height tripled from 97.3cm to 293.4cm within a space of 21days for plots that received poultry manure treatment. This is similar to the reports of Madukwe *et al*. (2008) and Christo *et al.* (2008) who studied the application of poultry manure on growth characteristics of cowpea.

The height of maize plant and its leaf length increased with the application of organic manure but retarded in the unamended plots, which could be due to the immobilization of the essential nutrients available in the soil for the growth of the plant (Onweremadu & Dumigbo 2007).

TABLE 1. SOIL PHYSICAL AND CHEMICAL PROPERTIES BEFORE CRUDE OIL APPLICATION AND AT 28 DAYS AFTER CRUDE OIL/ORGANIC MANURES APPLICATION

S/N	Soil properties	Before crude oil application	After 28days of crude oil/organic manure application			
			Poultry manure plots	Cow dung plots	Farm yard plots	Unamended
1	pH	6.16	6.12	5.86	5.42	4.48
2	Organic carbon (O.C) (%)	1.43	2.72	2.32	2.12	1.62
3	Organic matter (O.M) (%)	2.48	4.32	3.42	3.23	1.23
4	Total Nitrogen (TN) (%)	0.12	0.31	0.28	0.15	0.03
5	Available Phosphorus (P) (IPPM)	3.10	3.10	2.80	3.19	2.36
6	C.E.C (Cmol/kgsoil)	5.04	3.96	3.86	3.09	1.78
7	Potassium (K+) (Cmol/kgsoil)	0.20	0.15	0.2	0.22	0.11
8	Sand (%)	86.00	80.00	85.00	86.00	92.00
9	Silt (%)	8.00	12.00	9.00	10.00	2.00
10	Clay (%)	6.00	8.00	6.00	4.00	6.00

TABLE 2. EFFECT OF MANURE ON MAIZE SEED GERMINATION IN CRUDE OIL POLLUTED SOIL

Treatment	Men Number of day to germination	Mean germination percentage (%)
A. Crude oil		
0 ml	3.0^{b}	100^{a}
100 ml	3.21^{b}	88^{b}
200ml	3.36^{b}	65^{c}
300 ml	4.43^{a}	45^{d}
B. Manure		
Poultry	3.0^{b}	98^{a}
Cow	3.12^{b}	87^{b}
Farm yard	3.21^{b}	88^{b}
Unamended	4.22^{a}	41^{c}

Mean with the same letter(s) on the same column are not significantly different at $p \leq 0.05$.

TABLE 3. EFFECT OF MANURE ON MAIZE GROWTH CHARACTERISTICS IN CRUDE OIL POLLUTED SOIL

Treatments	Mean plant height (cm)		Mean Leaf length (cm)		Mean Cob length (cm)	Mean Cob diameter (cm)
	3 WAP	6WAP	3WAP	6wap		
A. crude oil						
0ml	87.92^{a}	148.15^{a}	31.88^{a}	61.83^{a}	12.80^{a}	7.58^{a}
100ml	78.7^{b}	140.45^{b}	29.65^{b}	53.93^{b}	10.4^{ab}	6.45^{ab}
200ml	68.23^{c}	136.75	27.93^{b}	51.03^{b}	9.6^{b}	6.40^{ab}
300ml	66.68^{c}	137.00^{c}	25.70^{c}	48.80^{c}	7.80^{c}	5.42^{b}
B. Manure						
Poultry	97.39^{a}	293.40^{a}	36.65^{a}	67.28^{a}	14.69^{a}	8.25^{a}
Cow	58.18^{c}	140.80^{c}	24.90^{c}	42.18^{b}	9.4^{bc}	6.40^{b}
Farmyard	83.83^{b}	156.50^{b}	31.48^{b}	65.33^{a}	12.30^{ab}	8.40^{a}
Unamended	51.79^{d}	63.90^{d}	22.23^{c}	36.80^{b}	6.27^{c}	2.80^{c}

Means with the same letter(s) in the same column are not significantly different at $p \leq 0.05$.

TABLE 4. EFFECT OF MANURE ON MAIZE YIELD CHARACTERISTICS IN CRUDE OIL POLLUTED SOIL

Treatments	Mean No of seeds per cob	Mean weight of 100 seeds (g)	Mean maize yield (Kg) ha
A. Crude oil			
0ml	246.40a	0.41a	2441.10a
100ml	230.30b	0.32b	2066.00b
200ml	230.60b	0.40a	1644.20c
300 ml	154.80c	0.30b	1355.8d
B. Manure			
Poultry	265.50[a]	0.50[a]	2477.10[a]
Cow	188.50[b]	0.40[ab]	1993.70[c]
Farm yard	253.00[ab]	0.40[ab]	2040.00[b]
Unamended	87.60[c]	0.20[c]	995.8[d]

Means with the same letter(s) in the same column are not significantly different at $p \leq 0.05$.

The application of manure also improved the quality of cob produced by the maize plant, with poultry manure treatment producing the longest cob, while the unamended plots produce the shortest cobs. This could be due to the decreasing effect of the crude oil contributed by the applied organic manures.

Generally, the results showed that the yield of maize was substantial with the application of manure. However, poultry manure treated-plots significantly produced the highest yield of 2,477.1 kg/ha compared to the yield obtained from plots treated with farm yard manure and cow dung (2,040.0kg/ha and 1993.7kg/ha respectively). The yield produced by the maize on these plots was undoubtedly as result of the combination of factors of which sufficient nutrient supply from the organic manures played a greater role. This is in line with previous reports (Cunningham & Philip 2000; Onweremadu & Duruigbo 2007) that showed plants to grow better with adequate soil nutrients even in the face of oil pollution.

In conclusion, the results from this study showed that there was positive interaction between the crude oil and the organic manures, as there were significant improvements in the measured attributes of maize plant growth as opposed to the maize plant grown without the organic manures. However, poultry manure proved better organic manure in the remediation of crude oil-polluted soils for maize cultivation.

REFERENCES

Adedokun, O. M. & Ataga A. E. 2006. Effects of amendments and bioaugumentation of soil polluted with crude oil automotive gasoline oil, and spent engine oil on the growth of cowpea (*Vigna unguiculata* L. Walp). *Scientific Research and Essay* 2(5):147-149.

Amadi, A.; Samuel, D. A. & Anthony, M. 1994. The Effect of crude oil spoilage on the soil microbial properties of a tropical rainforest. *Journal of water, air and soil pollution*. 67(1-3):28-30.

Asuquo, F. E.; Ibanga, I. J. & Hungafa, N. 2001. Effects of Qua Iboe crude oil contamination on germination and growth of Okra (*Albemoschus esculentus L.)* and fluted pumpkin (*Telfaria occidentalis* L.). *Proceeding of the 27th Annual conference of the soil science society of Nigeria* Nov. 5th – 9th, 2001 University of Calabar, Nigeria.

Baek, K. H. & Kim, H. S. 2004. Effect of crude oil, oil compounds and bioremediation on plant growth. *Journal of Environmental Science,* 39(9):2465-2472.

Basra, S. M. A.; Farooq, M.; Afzal, I. & Hussain, M. 2006. Influence of osmopriming on the germination and Early Seedling growth of Coarse and fine Rice. *International Journal of Agriculture and Biology* 8(1):19-22.

Christo I. E. C.; Madukwe, D. K. & Onuh, M. O. 2008. Growth and yield of cowpea (*Vigna unguiculata* (L.) Walp). as influenced by cultivar and Organic manure Source in the Humid Tropical Environment. *International Science Research Journal* 1(1):47-52.

Cunningham, C. J. & Philip, J. C. 2000. Comparison of biostimulaiton in ex-situ treatment of diesel contaminated soil. *Land contamination and Reclamation* 8:261-269.

James, A. H.; Paul, B. & John, P. 1996. *Land Restoration and Reclamation Principle and Practice.* Peston Publishing Company, Inc. U.S.A.

Kayode, G. O. & Agboola A. A. 2003. Effect of different Nitrogen levels, plant populations and soil Nutrient status on yield and yield components of maize in different ecological zones in Nigeria. *Nutrient cycling in Agroecosystem* 2(3): 177-191.

Madukwe, D. K.; Christo, I. E. C. & Onuh, M. O. 2008. Effect of organic manure and cowpea (vigna unquiculata (L.) Walp) varieties on the chemical properties of the soil and root nodulaiton. *Science World Journal* 3(1):43-46.

Ogbohodo, I. A.; Iruafa, E. K.; Osenwota, I.O. & Chokor, J. U. 2001. An assessment of the effect of crude oil pollution on soil properties; germination and growth of maize. *Proceedings of the 27th annual conf. Of the soil science society of Nigeria* Nov 5th – 9th 2001, University of Calabar, Nigeria.

Onuh, M. O. & Igwemma A. A. 2001. *Statistical Techniques for Business and Basic Science.* Christian Resource Centre Publications, Owerri, Nigeria.

Onweremadu, E. U. & Duruigbo C. E. 2007. Assessment of Cd concentration of crude oil polluted arable soils. *International journal of Environmental Science Technology* 4(3):409-412.

Rasheed, M.; Ali, H. & Mahmood, T. 2004. Impact of Nitrogen and Sulfur application in growth and yield of maize [Zea mays (L.)] Crop. *Journal of Research (Science).*15(2):153-157.

Sasikumar, C. S. & Taniya, P. 2003. Environmental Management: Bioremediation of polluted environment. *Proceeding of the third International Conference of Environment and Health* Chennai India 15 – 17 December, 2003. Chemia. University of Madra. Pg 465 – 469.